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THE SPATIAL DELINEATION OF THE FRENCH HAKE MARKET

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Abstract

The French market is one of the most important markets for hake within the European Union (EU). The aim of this paper is to spatially delineate and assess the scope of this market. Recent advances in market delineation methodologies permit interactions between elements (such as species) to be better identified within a multivariate framework. In this paper co-integration methodologies are undertaken to test for the existence of long run relationships for hake between the different auction markets within France. This paper is integrated into an European Project concerning the modelisation of the hake market in Europe.

Introduction

Hake is traditionally an important species in terms of revenue for Spanish, French and Italian fishermen. Table 1 illustrates that, in recent periods, hake is the fourth most important French fresh fish product with regards to monetary value, and approximately the tenth in terms of quantity.

Table 1 Principal fresh fish products in France.

	1 99 4		1 99 5	
	Quantity (T)	Value (MF)	Quantity (T)	Value (MF)
Total of the fresh fish production	**417940**	**4635.9**	**382319**	**4536.2**
Whiting	12501	297.4	15646	353.1
Cod	8631	328	9108	349.9
Monkfish	14421	289.4	15237	310.0
Hake	**13917**	**170.2**	**16226**	**180.3**
Pink Shrimp	29246	144.2	29300	157.7
Sole	25563	149	24733	154.6

T = tones
MF = million francs
source : FIOM

Despite this importance relatively few studies have focused on French hake production. Recent years have seen an increasing polarity North-South of the market trend but little is known about the scope of these markets. The implications of this and other factors (such as fisheries management policy) are therefore unknown.

In this paper interactions between French auction market prices for hake are investigated using Johansen multivariate cointegration techniques. If interactions are identified then those auction markets involved are likely to form part of the same sub-market and their prices will generally move together in the long-run. The question raised is whether there is one common French market for hake, such that there is a long run convergence of all port prices, or whether sub-markets exist where groups of ports display co-movements in their prices.

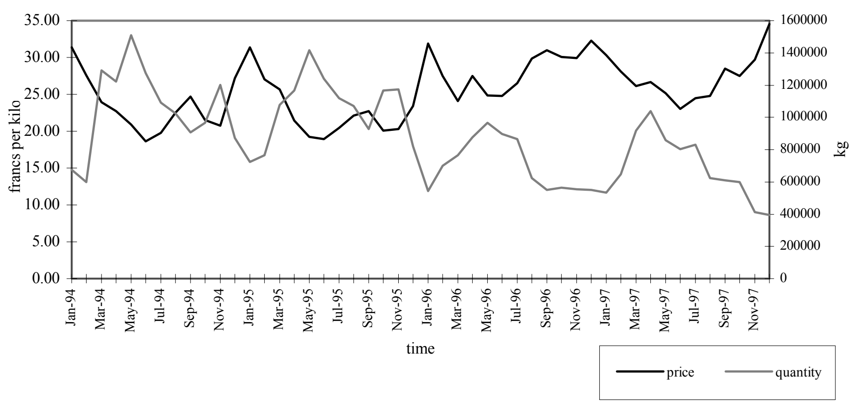
The general purpose of this paper is therefore to determine whether the hake prices of the French auction markets follow similar long-run trends, even if, in the short-run dis-equilibrium points appear. In such cases cointegration is verified and the ports involved may be considered substitutes.

French Hake Production

The national production of hake is relatively concentrated. The largest French port, Lorient, contributes up to 13-14 % of national production. The five largest ports produce just under fifty percent of the national output, while the ten largest ports produce over 70 percent (FIOM base data). Individual port production is displayed in Figure 1 in Annex 1.

Monthly data for both the French price and production of hake, for the period between 1994 and 1997, is illustrated in Figure 1. From this, production can be seen to follow a general downward trend over the time period, while prices have followed an upward trend.

Figure 1: National Hake Production



Market Delineation

There is a growing literature on market delineation using time series techniques in the testing for price interdependencies (Horowitz 1980, Stigler 1985, Benson and Faminow 1990 and Schrank and Roy 1991) and the majority are based upon Stigler's (1969) arbitrage-based definition of a market. Whereby Stigler classifies a market as the area "within which the price of a commodity tends to uniformity, allowance being made for transportation costs".

Since most price series generally tend to be non stationary, cointegration analysis (the only occasion where it is possible to infer causal long-run relationships between non-stationary variables) has become the most commonly used methodology for delineating markets (Ardeni 1989, Goodwin and Schroeder 1991, Gordon, Salvanes and Atkins 1993, Asche, Salvanes and Steen 1997 and Jaffry et al 1998). The implication of identifying cointegration is the existence of a stable long-run relationship. From which it can be assumed that a price parity equilibrium condition exists as a result that the variables form parts of the same market.

One associated problem with cointegration analysis when delineating markets is that variables could be shown to cointegrate even though one or more of the variables does not contribute significantly to the long-run relationship (Hamilton 1994). Under such circumstances, "weak" cointegration may exist between variables that have independent processes, but are subject to say similar demand shocks rather than relevant economic activities such as arbitrage and substitution. In order to correct for this, so-called exclusion tests are undertaken (Slade 1986; Steen 1985; Gordon and Hannesson and Asche, Slavanes and Steen 1997) by imposing null restrictions on the long-run parameters.

Cointegration Methodology

Prior to testing for cointegration it is necessary to verify the variables integration order. The most common methodology is the unit root test developed by Dickey and Fuller (1979; 1981). If a series must be differenced d times before it becomes stationary, thus containing d unit roots, it is said to be integrated of order d and is denoted as being I(d). Variables that are stationary in their levels, i.e. I(0), should be discarded from cointegration analysis. In most circumstances it is not strictly necessary for all the variables in question to have the same order of integration but it is important to understand the implications when all variables are not all I(1) (Harris 1995).

If two I(d) time series, x_t and y_t, are considered, then any linear combination will also be I(d). If, however, a vector β exists such that the disturbance term of the regression is of a lower order of integration, i.e. I(d-b) where b>0, then these variables are said to be cointegrated of order I(d,b) (Engle and Granger 1987).

Engle and Granger specify an autorregresive bivariate model such that:

$$Y_t = \phi_0 + \phi_1 \cdot X_t + \phi_1 \cdot X_{t-1} - \phi_1 \cdot X_{t-1} + \phi_2 \cdot x_{t-1} + \phi_3 \cdot Y_{t-1} + \varepsilon_t \qquad (1)$$

After optimum transformations, equation (1) can be rewritten in ECM form including both long- and short-run aspects such that:

$$\Delta Y_t = \phi_1 \cdot \Delta X_t - (1 - \phi_3) \cdot (Y_{t-1} - \beta_0 - \hat{\beta}_1 \cdot X_{t-1}) + \eta_t \qquad (2)$$

where η_t~IDD(0, σ^2).

Earlier cointegration studies have used this Engle and Granger bivariate approach (Ardeni 1987 and Goodwin and Schroeder 1991) and tested residuals (from ordinary least squares (OLS) estimations of the parameters of possible cointegration relations) for stationarity. Two primary problems arise with bivariate market delineation techniques. Firstly, the variable to be treated as endogenous is unknown. The regression (producing the residuals on which the test is based) therefore incorporates an arbitrary normalisation. The choice of which variable to normalise can lead to conflicting cointegration results. Secondly, testing parameter restrictions is not permitted within this bivariate framework.

Johansen (1988,1991) and Johansen and Juselius (1990), however, illustrate a procedure avoiding these problems. Their procedure determines the number of cointegration vectors within a given set of variables and has become widely used in recent market delineation studies (Asche, Salvanes and Steen 1997 and Jaffry *et al* 1998).

Under this Johansen approach the data is divided into two groupings, the variables in their levels and their first differences[1]. Using the technique of canonical correlation, the linear combinations of the data (in their levels) that are highly correlated with the differences are found. If the correlation is sufficiently high, then it follows that these linear combinations are stationary, and thus so are the cointegration vectors.

More formally a vector $\mathbf{z}_t$ can be defined, containing *n* potentially endogenous variables, where it is possible to specify a data generating process and model $\mathbf{z}_t$ as an unrestricted vector autoregression (VAR) with up to k-lags of $\mathbf{z}_t$:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \Phi D_t + \mu + \varepsilon_t \qquad (3)$$

where $\mathbf{z}_t$ is (n×1), each of the A_i is an (n×n) matrix of the parameters, D_t are seasonal dummies orthogonal to the constant term μ and ε_t ~ niid(0,Ω). Equation (3) can be reformulated in vector error-correction (VECM) form:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \ldots\ldots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \Phi D_t + \mu + \varepsilon_t \qquad (4)$$

where, Γ_i = -(I -A_1-…-A_i), (i =1, … ,k-1), and Π.= - (I - A_1 - … - A_k). The system now contains information on both the short- and the long-run adjustment to changes in $\mathbf{z}_t$. The rank of Π, denoted as r, determines how many linear combinations of $\mathbf{z}_t$ are

[1] Differences are to be assumed, under assumption of I(1) to be stationary.

stationary. Whereby $\Pi=\alpha\beta'$, where α represents the speed of adjustment to dis-equilibrium and β is a matrix of long-run coefficients and contains the cointegration vectors.

The number of significant vectors can be determined by using two different tests. The first of which, is the Maximum eigenvalue test (ξ), which is a test of the relevance of column r+1 in β; $\xi_r = - T\ln(1-\lambda_{r+1})$. The second is the trace test, (η_r) and is a likelihood ratio test for at most, r cointegration vectors; $\eta_r = -T \Sigma^N_{i=r+1} \ln(1-\lambda_i)$.

Application to the French auction market data

French auction market data was obtained for over 40 ports with the collaboration of FIOM[2]. Several ports were discarded from the analysis to low landings levels, and others due to missing values (data points) causing technical problems when using time series software. Monthly data (mean monthly sale prices for hake) was considered for the remaining 31 ports for the period between January 1994[3] and December 1997.

Cointegration Results

All 31 prices series were found to be non-stationary and were subsequently included in the analysis. In terms of a bivariate framework there is little evidence of a common market for hake within France. Since the "curse of dimentionality" (Hendry 1996) hinders nesting all the tests into the same system. Specification of multivariate systems therefore relied more on factorial analysis and *a priori* expectations than bivariate cointegration results.

While bivariate testing results do provide some indication of a small number of that might potentially form sub-markets. This analysis was insufficient to conclude inter-relationships within the whole set of price series. Since *a priori* expectations suggest that ports within close proximity of each other might be expected to compete in the same sub-markets, the ports were therefore classified into categories on a regional basis. Factorial analysis undertaken on the 31 ports appeared to add weight to this assumption, suggesting similar groupings. The port were ranked and grouped using

[2] Fond D'Intervention et d'Organisation des Marchés. The organisation in charge of building and managing the RIC (Reseau Inter Criee) database which records the sales of French action markets in terms of size, quality and presentation categories.

[3] The starting date of the RIC database.

factorial analysis[4] (in terms of the proximity of ports). Where the proximity between two ports (i and l) is mathematically defined as follows:

$$d^2(i,l) = \sum_{k \in K} (X_{ik} - X_{lk})^2 \qquad (5)$$

Eight intra-regional groups were subsequently derived from this factoral analysis and *a priori* expectations and are displayed in Figure 2.

Figure 2

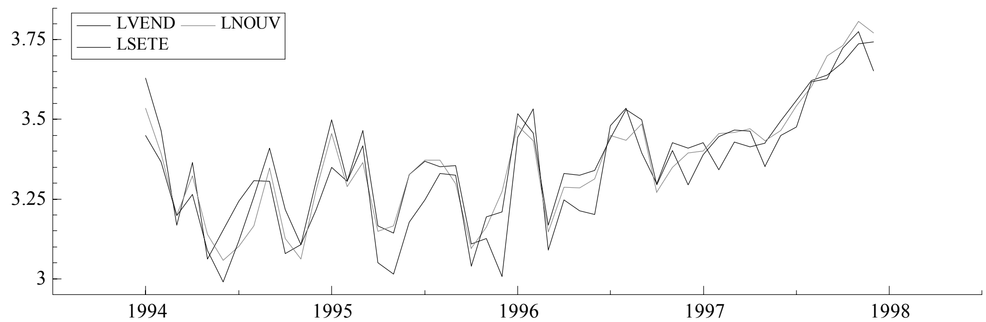
1.- **Normandie** : Port-en-Bessin and Cherbourg,
2.- **North-Brittany** : Saint-Malo, Roscoff, Brest and Douardenez,
3.- **South-Brittany (1)** : Audierne, Saint Guenole, Le Guilvinec, Lesconil,
4.- **South-Brittany (2)**: Loctudy, Concarneau, Lorient and Quiberon
5.- **Loire Atlantique** : Le Croisic, Noirmoutier, Saint Gilles Croix de Vie and Ile d'Yeu,
6.- **La Vendée** : Les Sables d'Olonne, La Rochelle and Royan,
7.- **La Gironde plus le Pays Basque français** : Arcachon, Saint Jean de Luz and Hendaye,
8.- **The Mediterranean coast** : Port Vendrés, Port la Nouvelle, Agde, Sète, and Grau du Roi.

Multivariate systems were specified for each regional grouping and their corresponding multivariate cointegration results are displayed in Annexe 1 (Tables 1-9). In each system one cointegration vector was identified. This indicates the presence of (at least) seven separate sub-markets for hake within France.

In the South-Brittany and Mediterranean group, however, such results were not immediately identifiable. In both cases there was no immediate evidence of a common market, i.e. one cointegration vector. Plotting the Mediterranean price series in graphical form (Figure 3), however, displays a general co-movement between prices. The lack of evidence of a common Mediterranean market arises with a divergence from the group's co-movement by AGDE in the latter stages of 1996. A dummy variable was included to account for this and a common market was subsequently found.

Figure 3

[4] Such a classification is illustrated in annexe 3



Similarly in the South-Brittany group a single common market could not immediately be identified. Cointegration was, however, identifiable in numerous sub-groupings within this South-Brittany group. This strong evidence of cointegration within the group infers the existence of a common market for the grouping as a whole.

Having established seven sub-markets on a regional basis, i.e. intra-regional markets, inter-regional markets were investigated in an attempt to identify one common market for all French ports. Such that, if inter-regional interactions are identified, then assumptions about a common hake market for French ports can be made.

Estimations of numerous combinations of inter-regional ports produced evidence of cointegrated markets. The most significant, to infer a common French market, is a group comprising of one port belonging to each coastal region. Such a multivariate system is estimated, consisting of Port-en-Bessin (Normandie), Brest (Brittany), La Rochelle (La Vendée), Saint Jean de Luz (The Basque Country) and Sète (Mediterranean Coast). The cointegration results of which are displayed in Table 9 in Annex 1. Again one cointegration vector is identified. In other words, an inter-regional market has been identified.

Conclusions and Discussions

This is the first effort to analyse the scope of the French market for hake. The results of bivariate analysis provide little evidence of a common hake market in which all French ports interact and compete. Similarly, there is also a lack of evidence for many sub-markets within France. Factorial analysis and *a priori* expectations, however, suggest otherwise. Under these analyses, ports belonging to a localised area are thought to compete and therefore comprise a market segment (sub-markets).

In terms of this intra-regional analysis, multivariate cointegration testing identifies at least seven potential regional groupings. All seven potential markets “pass” so-called exclusion testing and the French hake market is therefore classified into seven regionalised sub-markets.

From graphical analysis most of the 31 ports are seen to follow similar long-run patterns. Hendry’s curse of dimentionality, however, prevents nesting all these ports together in one system. Identifying a common market is therefore not strictly feasible in this paper. Instead an inference has been made following the assumption that strong evidence of inter-regional markets should imply the existence of a common French hake market.

Such robust[5] inter-regional markets are identifiable and subsequently infer the existence of a common hake market for French ports. It is now necessary to assess the scope of this proposed market. To determine whether this market stands alone or whether it is a segment within a larger, international market. In either case the regional sub-markets are all being influenced by a general “attractor”. A force driving the system to its long-run equilibrium. One possibility is the presence of a dominant national market, group of markets or even region driving the system. This would indicate a separate French hake market. Alternatively, French ports might be being driven by an international driver market (or group of markets). This would infer the French market to be a segment within an international market.

Future research must be directed at the identification of this driver market. Since Spain is the most important hake market within Europe and has strong commercial relationships with the French market[6]. *A priori* expectations would suggest Spain or at least Spanish ports as potential candidates.

[5] in the sense that the markets “pass” so-called exclusion testing.

[6] Spain is actually the most important customer of the French fish supply *REF*

Annex 1

Mean annual production of hake in France by port (period 1994-1997)

ranking	PORT	quantity sold (T)
1	LORIENT	1 433,14
2	LATURBALLE	834,51
3	SAINT GILLES CROIX DE VIE	824,26
4	CONCARNEAU	798,35
5	LE GUILVINEC	701,78
6	LES SABLES D'OLONNE	690,97
7	ILE DYEU	605,59
8	SETE	550,59
9	SAIN TGUENOLE	515,90
10	OLERON	498,98
11	LOCTUDY	497,62
12	ST JEAN DE LUZ	296,02
13	GRAU DU ROI	280,33
14	HENDAYE	250,42
15	PORT LA NOUVELLE	208,38
16	LAROCHELLE	198,91
17	PORT DE BOUC	197,02
18	LESCONIL	177,87
19	ARCACHON	164,89
20	LECROISIC	138,05
21	DOUARNENEZ	93,99

ranking	PORT	quantity sold (T)
22	QUIBERON	93,26
23	AGDE	72,05
24	PORT VENDRES	61,98
25	NOIRMOUTIER	45,71
26	ROYAN	43,94
27	ROSCOFF	43,43
28	CHERBOURG	35,60
29	SAINT MALO	35,11
30	BOULOGNE/MER	34,58
31	BAIE DE ST BRIEUC	28,83
32	PORT EN BESSIN	19,00
33	BREST	14,45
34	ERQUY	8,96
35	SAINT QUAY PORTRIEUX	6,21
36	AUDIERNE	5,52
37	CAMARET	0,49
38	GRANVILLE	0,26
39	FECAMP	0,06
40	DIEPPE	0,06
41	GRANDCAMP	0,01

T = tones

source : FIOM

Annex 2

Table **1** : Johansen (multivariate) test. *Normandy ports*

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	55.81**	19	66.52**	25.3
p <= 1	10.71	12.3	10.71	12.3

** significant at level 1%

Table **2** : Johansen (multivariate) test. North-Brittany ports

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	33.19*	31.5	66.62*	63
p <= 1	19.71	25.5	33.43	42.4
p <= 2	8.089	19	13.72	25.3
p <= 3	5.635	12.3	5.635	12.3

* significant at level 5%

Table **3** : Johansen (multivariate) test. *Gironde and Basque Country ports*

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	28.83**	17.9	39.47**	24.3
p <= 1	10.49	11.4	10.64	12.5
p <= 2	0.1575	3.8	0.1575	3.8

** significant at level 1%

Table **4** : Johansen (multivariate) test. *La Loire Atlantique ports*

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	38.59**	23.8	49.41**	39.9
p <= 1	7.428	17.9	10.82	24.3
p <= 2	2.528	11.4	3.396	12.5
p <= 3	0.8675	3.8	0.8675	3.8

** significant at level 1%

Table **5** : Johansen (multivariate) test. South-*Brittany ports (1)*

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	48.59**	28.1	73.62**	53.1
p <= 1	17.1	22	25.03	34.9
p <= 2	4.568	15.7	7.93	20
p <= 3	3.362	9.2	3.362	9.2

** significant at level 1%

Table **6** : Johansen (multivariate) test. South-*Brittany ports (2)*

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	40.7**	27.1	67.17**	47.2
p <= 1	12.32	21	26.47	29.7
p <= 2	11.44	14.1	14.15	15.4
p <= 3	2.712	3.8	2.712	3.8

** significant at level 1%

Table **7** : Johansen (multivariate) test. La Vendée ports

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	38.7**	31.5	79.38**	63
p <= 1	23.78	25.5	40.68	42.4
p <= 2	10.61	19	16.9	25.3
p <= 3	6.283	12.3	6.283	12.3

** significant at level 1%

Table **8** : Johansen (multivariate) test. Mediterranean Coast ports

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	93.74**	34.4	141**	76.1
p <= 1	24.68	28.1	47.28	53.1
p <= 2	18.36	22	22.61	34.9
p <= 3	3.637	15.7	4.252	20
p <= 4	0.615	9.2	0.615	9.2

** significant at level 1%

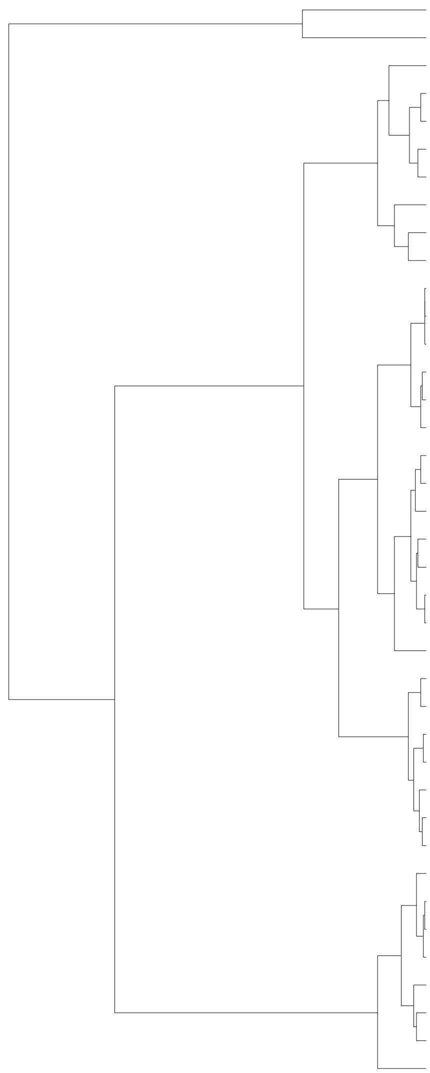
Table **9** : Johansen (multivariate) test. Port-en-Bessin, Brest,
La Rochelle, Saint Jean de Luz et Sète ports

Ho:rank=p	λ_{trace}	trace-test (95%)	λ_{max}	max-test (95%)
p = 0	68**	37.5	129.9**	87.3
p <= 1	27.82	31.5	61.89	63
p <= 2	17.15	25.5	34.07	42.4
p <= 3	14.34	19	16.92	25.3
p <= 4	2.583	12.3	2.583	12.3

** significant at level 1%

Annex 3

Factorial analysis of the hake sale price series of the French action markets



	A	B	C	D
02	Dieppe	40	1	I
06	Granville	38	2	I
11	Audierne	36	3	II
23	Ile d'Yeu	7	8	III
13	Guilvinec	5	9	II
04	Port-en-Bessin	32	15	I
39	St-Brieuc	31	7	II
29	St J. de Luz	12	12	IV
20	Le croisic	20	18	III
28	Arcachon	19	20	IV
32	P. la Nouvelle	15	11	V
34	Sète	8	17	V
31	Port Vendres	24	13	V
35	Grau du Roi	13	21	V
33	Agde	23	25	V
36	Port de Bouc	17	26	V
07	St Malo	29	14	II
21	Noirmoutier	25	19	III
05	Cherbourg	28	22	I
08	Roscoff	27	10	II
09	Brest	33	16	II
37	Erquy	34	4	II
38	St Quay P.	35	6	II
03	Fécamp	39	5	I
26	Oleron	10	35	IV
27	Royan	26	27	IV
22	St Gilles de Croix	3	30	III
19	La turbaille	2	32	III
12	St Guenole	9	24	II
24	Sables d'Olonne	6	29	III
25	La Rochelle	16	28	III
10	Douardenez	21	23	II
17	Lorient	1	36	II
15	Loctudy	11	33	II
16	Concarneau	4	31	II
18	Quiberon	22	39	II
30	Hendaye	14	34	IV
14	Lesconil	18	38	II
01	Boulogne	30	37	I

A : Fish Port

B : Ranking by price level

C : Ranking by supply level

D : Coastal region

(the level "D" corresponde to the marine area division made in Chaussade and Corlay (1990)

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